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Risø National Laboratory, DK-4000 Roskilde, Denmark
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ENVIRONMENTAL RADIOACTIVITY IN GREENLAND IN 1980

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Abstract. Measurements of fallout radioactivity in Greenland in 1980 are reported. Strontium-90 (and Cesium-137 in most cases) was determined in samples of precipitation, sea water, vegetation, animals, and drinking water. Estimates are given of the mean contents of ^{90}Sr and ^{137}Cs in the human diet in Greenland in 1980. Provisional results of the $^{239,240}Pu$ and ^{241}Am measurements on samples from the expedition to Thule in August 1979 and from the Swedish YMER expedition in 1980 are presented.

INIS Descriptors

[0] DEER, DIET, ENVIRONMENT, EXPERIMENTAL DATA, FISHES, FOOD CHAINS, GLOBAL FALLOUT, GRAPHS, GREENLAND, PLANTS, RADIOACTIVITY, SEAWATER, SHEEP, TABLES
[1] ATMOSPHERIC PRECIPITATIONS, DRINKING WATER, STRONTIUM 90
[2] CESIUM 137
[3] ALGAE, AMERICIUM 241, PLUTONIUM 239, PLUTONIUM 240, SEDIMENTS

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CONTENTS

ABBREVIATIONS AND UNITS

J: joule: the unit of energy; 1 J = 1 Nm (= 0.239 cal)
Gy: gray: the unit of absorbed dose = 1 J kg^{-1} (= 100 rad)
Sv: sievert: the unit of dose equivalent = 1 J kg^{-1} (= 100 rem)
Bq: becquerel: the unit of radioactivity = 1 s^{-1} (= 27 pCi)

cal: calorie = 4.186 J
rad: 0.01 Gy
rem: 0.01 Sv
Ci: curie: $3.7 \cdot 10^{10}$ Bq (= $2.22 \cdot 10^{12}$ dpm)

T: tera: 10^{12}
G: giga: 10^{9}
M: mega: 10^{6}
m: milli: 10^{-3}
μ: mikro: 10^{-6}
n: nano: 10^{-9}
p: pico: 10^{-12}
f: femto: 10^{-15}
a: atto: 10^{-18}

cap: caput: (per individual)
TNT: trinitrotoluol; 1 Mt TNT: nuclear explosives equivalent to 10^{9} kg TNT.

cpm: counts per minute
dpm: disintegrations per minute
OR: observed ratio
CF: concentration factor
FP: fission products
μR: micro-roentgen, 10^{-6} roentgen
S.U.: pCi ^{90}Sr (g Ca)$^{-1}$
O.R.: observed ratio
M.U.: pCi ^{137}Cs (g K)$^{-1}$

V: vertebrae
m: male
f: female
nSr: natural (stable) Sr

eqv. mg KCl: equivalents mg KCl: activity as from 1 mg KCl (~ 0.88 dpm)

S.D.: standard deviation: $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{(n-1)}}$

S.E.: standard error: $\sqrt{\frac{\Sigma(\bar{x}-x_i)^2}{n(n-1)}}$

U.C.L.: upper control level
L.C.L.: lower control level
S.S.D.: sum of squares of deviation: $\Sigma(\bar{x}-x_i)^2$
f: degrees of freedom
s^2: variance
v^2: ratio between the variance in question and the residual variance
P: probability fractile of the distribution in question
η: coefficient of variation, relative standard deviation
ANOVA: analysis of variance
A: relative standard deviation 20-33%
B: relative standard deviation >33%, such results are not considered significantly different from zero activity
B.D.L.: below detection limit

In the significance test the following symbols were used:
* : probably significant (P > 95%)
** : significant (P > 99%)
***: highly significant (P > 99.9%)

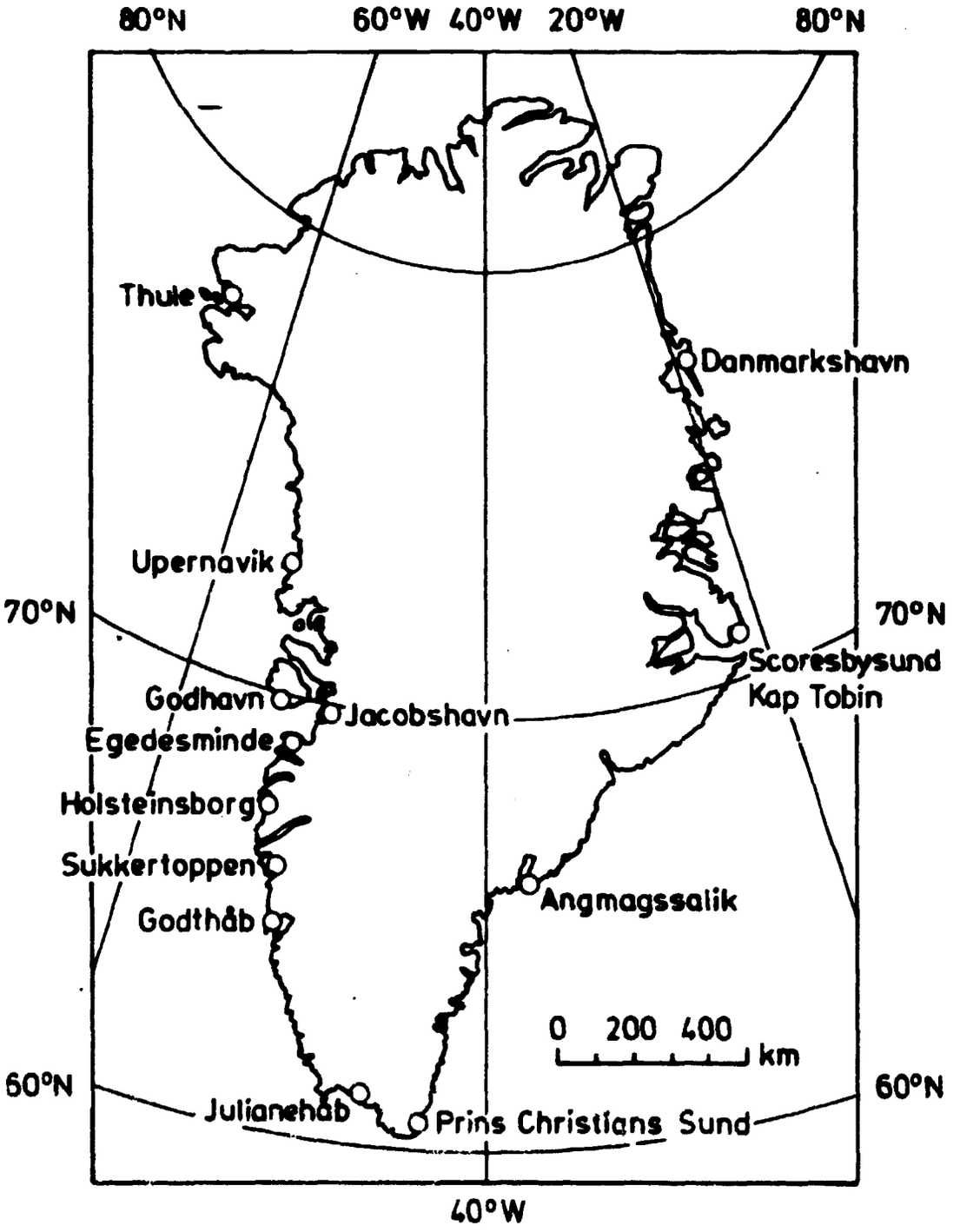

Fig. 1. Greenland.

1. INTRODUCTION

1.1.

In 1980 the sampling programme was similar to that used in previous years but for a few minor modifications.

1.2.

As hitherto, samples were collected through the local district physicians and the head of the telestations.

1.3.

The estimated mean diet in Greenland was the same as that in 1962, i.e., it agreed with the estimate given by Professor E. Hoff-Jørgensen, Ph.D.

1.4.

The environmental studies in Greenland were carried out together with corresponding investigations in Denmark (cf. Risø Report No. 447[2]) and in the Faroes (cf. Risø Report No. 448[3]).

1.5.

The present report does not repeat information concerning sample collection and analysis already given in ref. 1.

1.6.

In the appendices (A, B and C) we have as uncommented tables given provisional results of our investigations of transuranics (Pu and Am) and ^{137}Cs at Thule in August 1979. The expedition to Thule in 1979 was supported by the Commission of the European Communities with funds from its Radiation Protection programme. Furthermore, appendix D shows some provisional results from the Swedish YMER 1980 expedition. The samples were collected by Professor Bertil Persson and Dr. Elis Holm, Lund University.

2. RESULTS AND DISCUSSION

2.1. Strontium-90 in precipitation

Table 2.1.1 shows the results of the measurements.

Table 2.1.1. Strontium-90 in precipitation in Greenland in 1980

Location (m precipitation)	Unit	Jan-March	April-June	July-Sept	Oct-Dec	1980
Upernavik	Bq m^{-3}	20.1	16.4	8.1	9.8 *	11.8
Σ 0.313 (0.325)	Bq m^{-2}	0.71	1.20	0.97	0.82*	3.70
Godhavn	Bq m^{-3}	8.6	12.5	Station closed		
Σ	Bq m^{-2}	0.60	1.82			
Godthåb	Bq m^{-3}	12.8	8.9	7.2	5.7	8.2
Σ 0.576	Bq m^{-2}	1.19	1.52	1.12	0.91	4.74
Prins Chr. Sund	Bq m^{-3}	5.7	8.1	5.4	2.2	5.4
Σ 1.308	Bq m^{-2}	3.0	2.4	1.11	0.60	7.11
Kap Tobin	Bq m^{-3}	9.4	10.3	11.0	5.7 *	8.0
Σ 0.393 (0.376)	Bq m^{-2}	0.93	0.65	0.53	1.05*	3.16
Danmarkshavn	Bq m^{-3}	11.4	19.9	14.4	68.9	26.8
Σ 0.161	Bq m^{-2}	0.67	0.46	0.59	2.58	4.30

*Combined with Jan-March 1981.

The missing amount of precipitation was kindly supplied by Mr. Gunnar Nielsen, Danish Meteorological Institute. The annual amounts at the locations according to Danish Meteorological Institute are shown in bracket.

The ^{90}Sr levels in 1980 at the Greenland stations were 0.88±0.51 (1 S.D.) times the 1979 figures. In Denmark[2] and the Faroes[3] the fallout levels decreased similarly from 1979 to 1980.

Fig. 2.1 shows the accumulated ^{90}Sr at the various stations in Greenland, since measurements began in 1962.

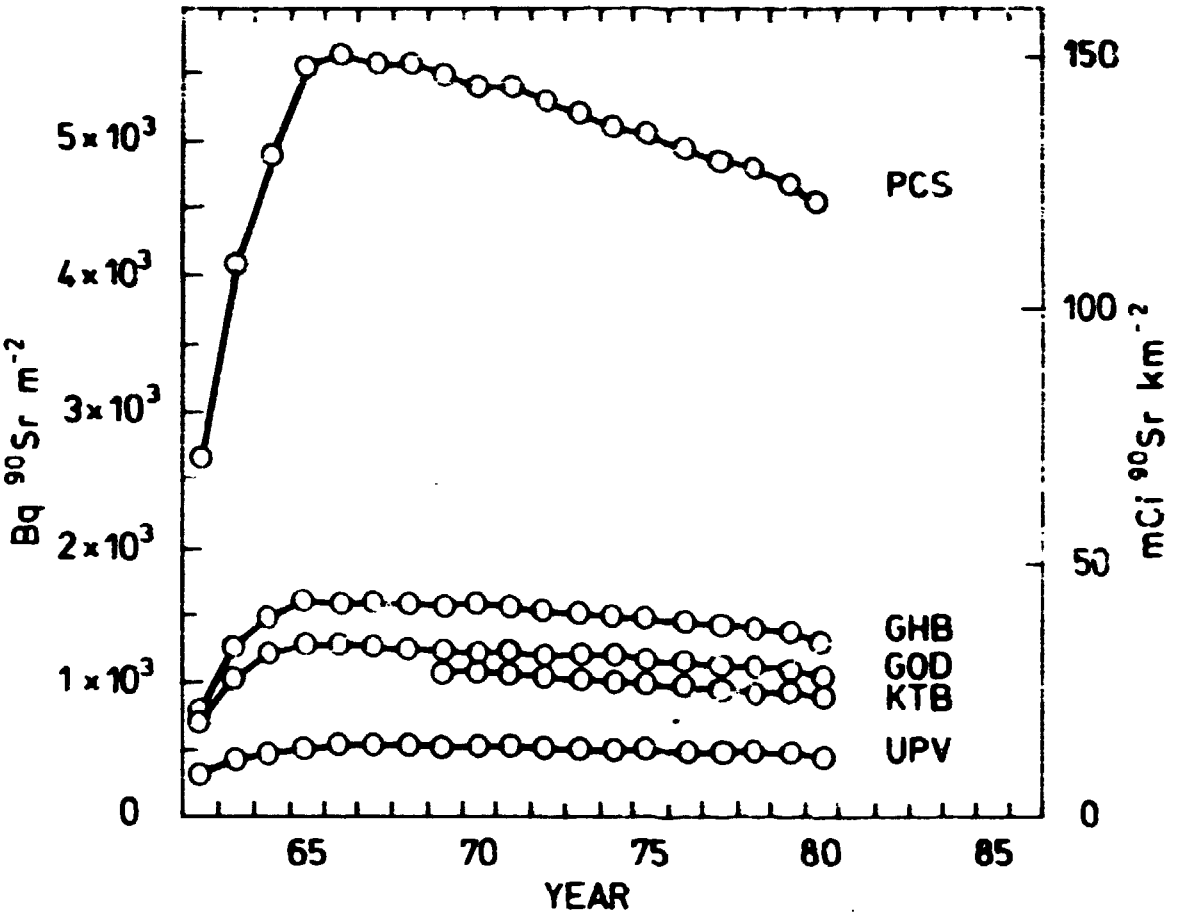

Fig. 2.1. Accumulated ^{90}Sr at Prins Chr. Sund, Godthåb, Godhavn, Kap Tobin and Upernavik calculated from precipitation measurements since 1962. The accumulated fallout by 1962 was estimated from the Danish data (cf. Risø Report No. 447[2], Appendix D) and from the ratio between the ^{90}Sr fallout at the Greenland stations and the fallout in Denmark in the period 1962-1974.

2.2. Strontium-90 in sea water

Four samples of surface water were obtained in August 1979. Table 2.2.1 shows the results. The ^{90}Sr level was comparable with those of the previous years. The $^{137}Cs/^{90}Sr$ mean ratio was 1.2 (1 S.D.), i.e. there was no indication of any surplus ^{137}Cs in Greenland waters in the 1980 samples.

Tritium was measured in sea water from 1979 and 1980 (Table 2.2.2), the levels corresponded to those found in sea water col-

lected in Denmark of similar salinities (cf. Risø Report No. 447[2], Tables 7.3.4 and 7.3.5).

The concentration in the East Greenland waters were as usual higher than the levels along the west coast of Greenland.

Table 2.2.1. Strontium-90 and Cesium-137 in sea water from Greenland in 1980

Location	Bq ^{90}Sr m^{-3}	Bq ^{137}Cs m^{-3}	Salinity o/oo
Danmarkshavn	6.0	6.6	28.6
Prins Chr. Sund	4.2	4.4	29.9
Angmagssalik	4.4	4.9	24.5
Godthåb	3.2	4.7	31.2
Mean	4.45	5.15	
Mean pCi l^{-1}	0.12	0.14	

Table 2.2.2. Tritium in sea water from Greenland in 1979 and 1980

Location	Date	kBq ^{3}H m^{-3} ±1 S.E.	Salinity o/oo
Godhavn	Aug 1979	2.4±0.18	34.2
Prins Chr. Sund	- " -	3.5±0.92	32.5
Danmarkshavn	1979	4.6±0.26*	29.1
Narssaq	June 1979	2.4±0.18	
Danmarkshavn	1980	7.4±0.00	2..6
Prins Chr. Sund	"	5.7±0.18	29.9
Angmagssalik	"	5.2±0.37	24.5
Godthåb	"	5.4±0.18	31.2

*Triple determinations.

The error term is 1 S.E. of the mean of double determinations.

Table 2.2.3. Cesium-137 in sea water collected in 1974, 1975 and 1976 around Greenland. Remeasured in 1981

Location		Date		Depth in m	Bq ^{137}Cs m^{-3}
62°41'N	61°11'W	July 26	1974	0	7.0
67°04'N	57°26'W	July 24	"	0	6.7
59°19'N	43°45'W	July 14	"	0	6.0
60°24'N	31°21'W	July 1?	"	0	5.1
60°41'N	26°00'W	July 10	"	0	5.0
61°02'N	20°50'W	July 9	"	0	4.5
61°26'N	15°34'W	July 8	"	0	4.9
61°51'N	10°22'W	July 7	"	0	9.6
61°20'N	04°50'W	July 5	"	0	4.7
76°30'N	69°25'W	Aug 18	"	0	3.0
"	"	"	"	199	2.6
76°31'30N	69°17'W	Aug 16	"	0	1.7 A
"	"	"	"	194	2.3
76°35'N	69°05'W	Aug	"	Bottom	2.0
60°32'N	46°25'W	Aug 22	1975	0	7.4
61°55'N	50°49'W	Aug 21	"	0	7.0
>5°40'N	53°55'W	July 31	"	0	8.5
64°14'N	52°49'W	Aug 13	"	0	8.1
Prins Chr. Sund		April, June	1976	0	6.7 B

2.3. Strontium-90 and Cesium-137 in terrestrial animals

Six samples of lamb were received from SW-Greenland in 1980. The mean levels were 0.24 Bq ^{90}Sr kg^{-1} meat and 42 Bq ^{137}Cs kg^{-1}. The lamb bones contained 2600 Bq ^{90}Sr (kg Ca)$^{-1}$.

Table 2.3. Strontium-90 and Cesium-137 in terrestrial animals collected in Greenland in 1980

Date	Location	Sample type	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$
February	Narssaq	Lamb meat II			72	18600
		" meat III			59	16300
		" meat IV			20	5100
August	SW-Greenland (KGH)	Lamb meat I	0.081	2000	27	10500
		" bone I	-	2350		
		" meat II	0.40	2800	31	11800
		" bone II	-	2900		
Mean (meat)			0.24	2.4	42	12500
Mean (meat)			6.5 pCi kg^{-1}	71 pCi (g Ca)$^{-1}$	1130 pCi kg^{-1}	340 pCi (g K)$^{-1}$

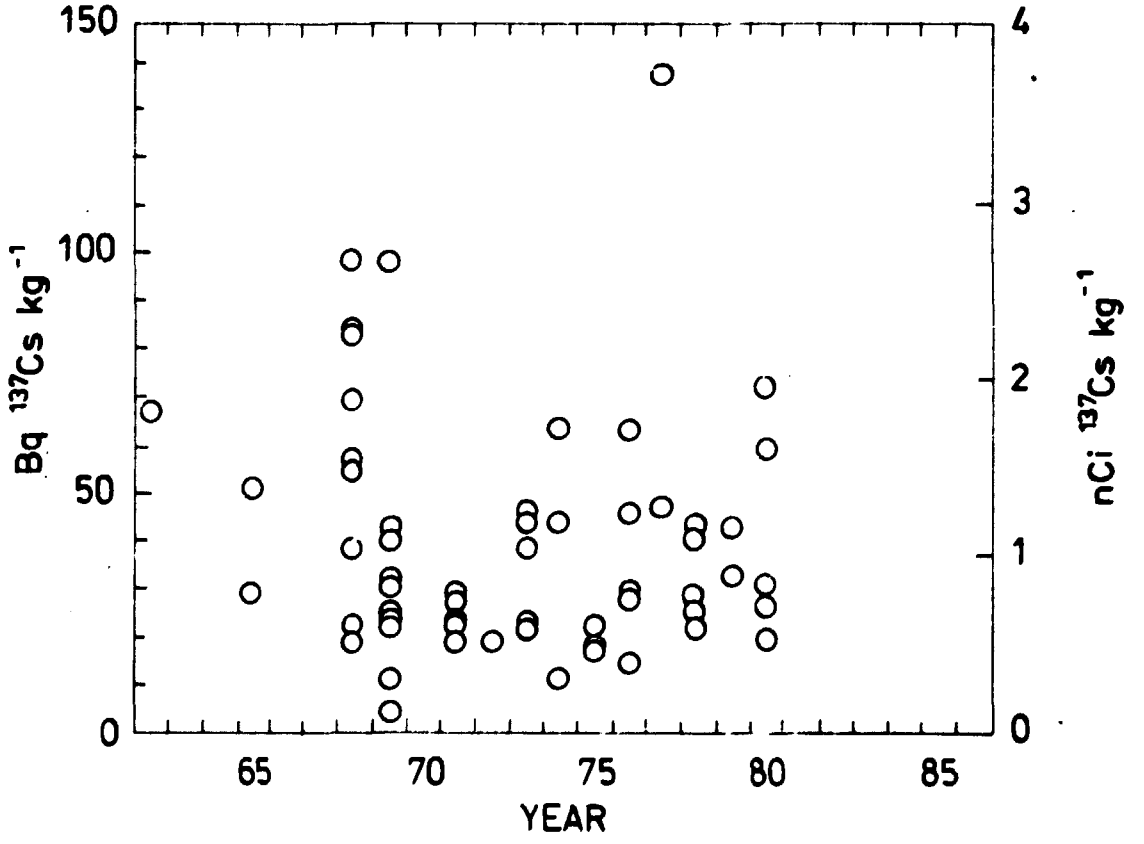

Fig. 2.3.1. Cesium-137 in mutton, 1962-1980.

2.4. Strontium-90 and Cesium-137 in sea animals

The mean levels in fish meat were: 0.0056 Bq ^{90}Sr kg^{-1}, 0.30 Bq ^{137}Cs kg^{-1}, and seal contained 0.0025 Bq ^{90}Sr kg^{-1} meat and 0.43 Bq ^{137}Cs kg^{-1}. Shrimps contained 0.0097 Bq ^{90}Sr kg^{-1} flesh and 0.12 Bq ^{137}Cs kg^{-1}.

Table 2.4.1. Strontium-90 and Cesium-137 in sea animals collected in Greenland in 1980

Date	Location	Sample	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr (kg Ca)$^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs (kg K)$^{-1}$
June	Angmagssalik	Seal meat	0.0025	33	0.50	205
		" bone	-	2.3	-	-
Aug	Jacobshavn	Seal meat	0.0025	75	0.36	125
		" bone	-	2.3	-	-
June	Angmagssalik	Angmasatter	0.014	6.8	0.79	249
	SW-Greenland (KGH)	Cod flesh	0.0025	31	0.56	136
	- " -	Salmon flesh I	0.0094	95	0.16	53
		" bone I	-	4.4	-	-
	- " -	Salmon flesh I	0.0050	48	0.19	55
		" bone I	-	16.9	-	-
	- " -	Shrimps flesh	0.0097	17.5	0.12	77
	Jacobshavn	Shrimps (total)	0.069	2.0	0.20	62

2.5. Strontium-90 and Cesium-137 in vegetation

Lichen, moss, grass and seaweed were collected at a few locations along the Greenland coast during the summer.

The ^{90}Sr and ^{137}Cs levels in lichen compared with those from previous years are shown in Fig. 2.5. As mentioned in Risø Report No. 405[1] the decrease observed in 1978 was probably due to the lack of samples from the west coast that year.

The geometric mean levels in moss and lichen were 92 Bq ^{90}Sr kg^{-1} and 450 Bq ^{137}Cs kg^{-1}.

A fucus sample was obtained from Prins Chr. Sund in June. It contained 0.055 Bq ^{90}Sr kg^{-1} (wet) (36% dry matter) (73 Bq ^{90}Sr $(kg\ Ca)^{-1}$) and 0.44 Bq ^{137}Cs kg^{-1} (42 Bq ^{137}Cs $(kg\ K)^{-1}$).

Table 2.5.1. Strontium-90 and Cesium-137 in terrestrial vegetation samples collected in Greenland in 1980

Date	Location	Species	Bq ^{90}Sr kg^{-1}	Bq ^{90}Sr $(kg\ Ca)^{-1}$	Bq ^{137}Cs kg^{-1}	Bq ^{137}Cs $(kg\ K)^{-1}$
Aug	Scoresbysund	Grass	2.2	1600	6.3	1300
"	- " -	Moss	92	11300	270	38000
"	Prins Chr. Sund	Moss I	144	16000	1120	155000
"	- " -	Moss II	-	-	200	53000
"	- " -	Lichen	59	33000	650	59000

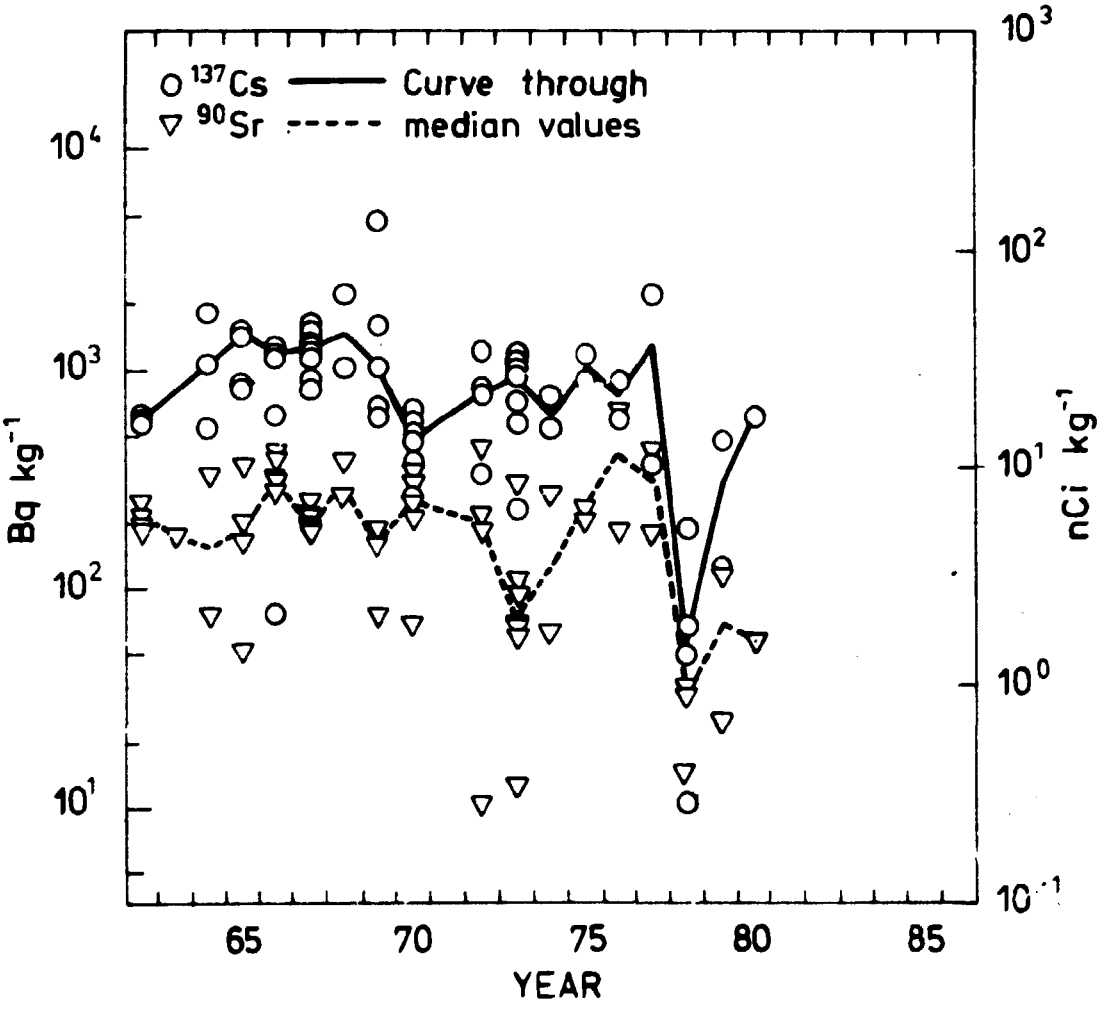

Fig. 2.5. Cesium-137 and Strontium-90 in lichen (fresh weight) collected along the Greenlandic coast, 1962-1980.

2.6. Strontium-90 in drinking water

Quarterly samples of drinking water were collected from a number of locations in Greenland. Table 2.6.1 shows the results from 1980, and Fig. 2.6 the geometric annual means of all samples for the period 1962-1980.

Table 2.6.1. Strontium-90 in drinking water collected in Greenland in 1979 and 1980. (Unit: Bq m^{-3})

Location	Jan-March	April-June	July-Sept	Oct-Dec
Danmarkshavn	74	52	7.3	49
Scoresbysund	20	14.5		
Prins Chr. Sund	132	46	44	210
Godthåb	17.1			
Upernavik	0.5 B	0.3 B		
Scoresbysund 1979			15.7	22

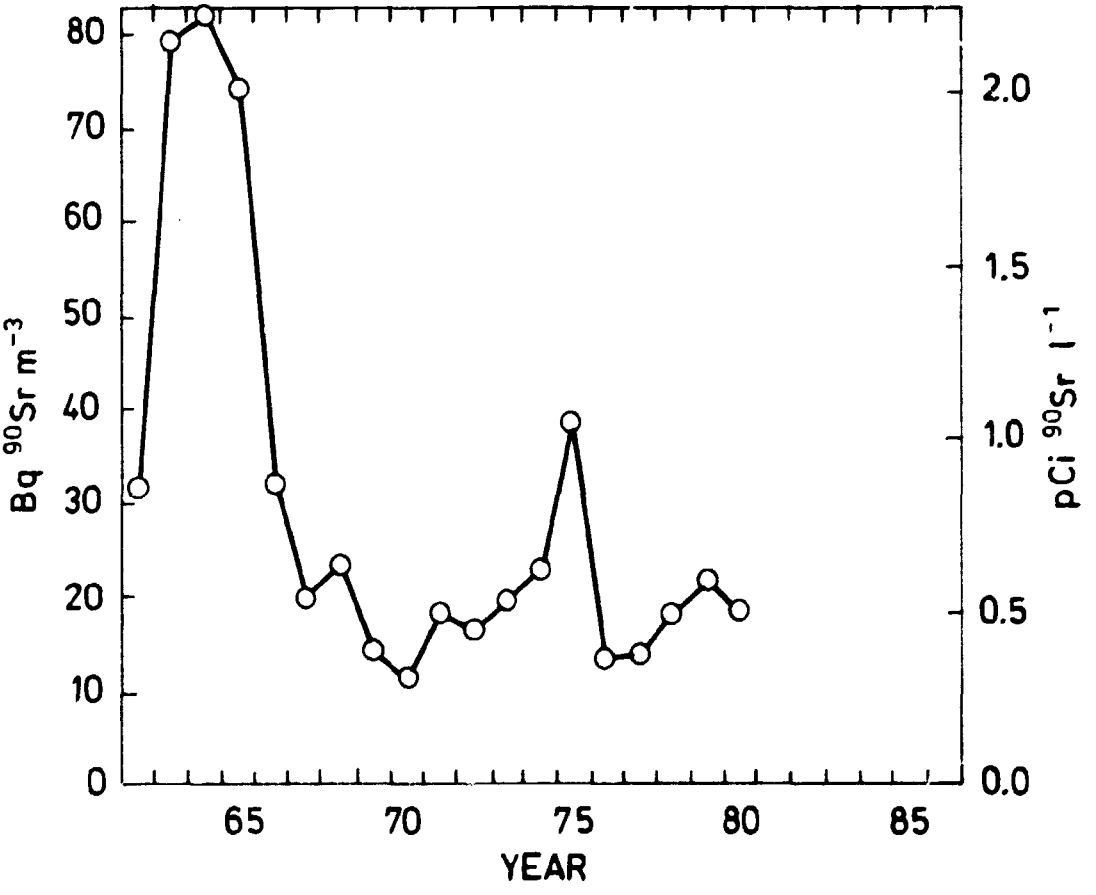

Fig. 2.6. Strontium-90 in Greenlandic drinking water (Geometric mean), 1962-1980.

As in previous years, we found it most expedient to choose the geometric mean of all figures, i.e. 19 Bq ^{90}Sr m^{-3} (0.53 pCi l^{-1}) as representative of the mean level of ^{90}Sr in Greenland drinking water in 1980, this level was not significantly different from that observed in recent years (Fig. 2.6). Some of the levels (e.g. those from Prins Chr. Sund) are surprisingly high as compared to present rain concentrations (cf. Table 2.1.1). We assume that evaporation from the drinking water reservoirs is responsible for the higher ^{90}Sr levels. Tritium measurements show (Table 2.6.2) that the drinking water at Prins Chr. Sund shows similar tritium levels as drinking water from other locations, hence evaporation seems to be a likely explanation. However, it is remarkable and not explainable at present, why Upernavik shows drinking water tritium concentrations just as high as those of the locations, despite the low ^{90}Sr levels in drinking water from Upernavik.

Table 2.6.2. Tritium in drinking water collected in Greenland in January-March 1980

Location	kBq ^{3}H m^{-3} ±1 S.E.
Danmarkshavn	7.6±0.92
Scoresbysund	4.1
Prins Chr. Sund	2.6±0.37
Godthåb	5.7±0.18
Upernavik	5.7±1.30

The error term is 1 S.E. of the mean of double determinations.

3. ESTIMATE OF THE MEAN CONTENTS OF ^{90}Sr AND ^{137}Cs IN THE HUMAN DIET IN GREENLAND IN 1980

3.1. The annual quantities

The estimate of the daily per capita intake of the different foods in Greenland is still based on the figures given in 1962 by Professor E. Hoff-Jørgensen, Ph.D., in Risø Report No. 65[1].

3.2. Milk products

All milk consumed in Greenland was imported as milk powder from Denmark. The mean radioactivity content in milk prepared from Danish dried milk produced in 1980 was 0.127 Bq ^{90}Sr kg^{-1} and 0.111 Bq ^{137}Cs kg^{-1} [2].

Cheese was also imported from Denmark and contained 0.90 Bq ^{90}Sr kg^{-1} and 0.080 Bq ^{137}Cs kg^{-1}.

3.3. Grain products

All grain was imported from Denmark. It is assumed that only grain from the harvest of 1979 was consumed in Greenland during 1980. The daily per capita consumption was: rye flour (100% extraction): 80 g, wheat flour (75% extraction): 110 g, rye flour (70% extraction): 20 g, biscuits (rye, 100% extraction): 27 g, and grits: 25 g. The content of ^{90}Sr in these five products was 0.74, 0.15, 0.15, 0.55 and 0.30 Bq kg^{-1} respectively. Hence the mean content of ^{90}Sr in grain products was 0.39 Bq kg^{-1}. The content of ^{137}Cs in the five products was 0.45, 0.14, 0.23, 0.34 and 0.16 Bq kg^{-1}. Hence the mean content of ^{137}Cs in grain products was 0.26 Bq kg^{-1}.

The activity levels in rye flour (100% extraction), wheat flour (75% extraction), and grits were all taken from Tables 5.9.1 and 5.9.2 in Risø Report No. 447[2]. The ^{90}Sr level in rye flour

(70% extraction) was calculated analogously with the level in wheat flour (75% extraction), i.e. as one-fifth of the whole-grain activity. The ^{137}Cs content in rye flour (70% extraction) was calculated as one half of the whole-grain level in rye in analogy with the ratio between ^{137}Cs in whole wheat grain and in wheat flour (75% extraction)[2]. The ^{90}Sr and ^{137}Cs contents in biscuits were calculated by dividing the levels of the rye flour (100% extraction) by 1.35, since 1 kg flour yields 1.35 kg bread[2].

3.4. Potatoes, other vegetables, and fruit

The Danish mean levels for 1980 were used[2] since the local production is insignificant compared with imports from Denmark.

The Danish mean levels were: in potatoes 0.083 Bq ^{90}Sr kg^{-1} and 0.077 Bq ^{137}Cs kg^{-1}, in other vegetables 0.34 Bq ^{90}Sr kg^{-1} and 0.084 Bq ^{137}Cs kg^{-1}, and in fruit 0.05 Bq ^{90}Sr kg^{-1} and 0.03 Bq ^{137}Cs kg^{-1}.

3.5. Meat

Nearly all meat consumed in Greenland is assumed to be of local origin. Approx. 10% comes from sheep, 5% from reindeer, 60% from seals, 5% from whales, and 20% from sea birds and eggs.

The activity in lamb was estimated from 2.3. Activity in seals was estimated from 2.4. The levels of whales, sea birds and eggs were taken from the 1978 analyses[1] and reindeer from 1979. Hence the mean levels in Greenland meat from 1980 were 0.031 Bq ^{90}Sr kg^{-1} and 5.8 Bq ^{137}Cs kg^{-1}.

(^{90}Sr: $0.1\times0.24 + 0.05\times0.072 + 0.6\times0.0025 + 0.05\times0.0013 + 0.2\times0.0070 = 0.031$ Bq kg^{-1})

(^{137}Cs: $0.1\times42 + 0.05\times24 + 0.6\times0.43 + 0.05\times0.70 + 0.2\times0.35 = 5.8$ Bq kg^{-1})

3.6. Fish

All fish consumed was of local origin, and the mean levels from 2.4 were used, i.e. 0.0056 Bq ^{90}Sr kg^{-1} and 0.30 Bq ^{137}Cs kg^{-1}.

3.7. Coffee and tea

The Danish figures for 1980[2] were used for coffee and tea, i.e. 0.66 Bq ^{90}Sr kg^{-1} and 2.21 Bq ^{137}Cs kg^{-1}.

3.8. Drinking water

The geometric mean calculated in 2.6 was used as the mean level of ^{90}Sr in drinking water, i.e. 19 Bq ^{90}Sr m^{-3}. The ^{137}Cs content was as previously[1] estimated at 1/4 of the ^{90}Sr content, i.e approx. 5 Bq ^{137}Cs m^{-3}.

Tables 3.1 and 3.2 show the diet estimates of ^{90}Sr and ^{137}Cs respectively.

Table 3.1. Estimate of the mean content of ^{90}Sr in the human diet in Greenland in 1980

Type of food	Annual quantity in kg	Bq ^{90}Sr per kg	Total Bq ^{90}Sr	Percentage of total Bq ^{90}Sr in food
Milk and cream	78	0.127	9.91	13.8
Cheese	2.5	0.90	2.25	3.1
Grain products	95.6	0.39	37.28	51.7
Potatoes	32.8	0.083	2.72	3.8
Vegetables	5.5	0.34	1.87	2.6
Fruit	13.5	0.05	0.68	0.9
Meat and eggs	45.6	0.031	1.41	2.0
Fish	127.6	0.0056	0.71	1.0
Coffee and tea	7.3	0.66	4.82	6.7
Drinking water	548	0.019	10.41	14.4
Total			72.06	

The mean annual calcium intake is estimated to be 0.56 kg (approx. 0.2-0.25 kg creta praeparata). Hence the $^{90}Sr/Ca$ ratio in Greenland total diet in 1980 was 129 Bq ^{90}Sr $(kg\ Ca)^{-1}$ or 3.5 pCi ^{90}Sr $(g\ Ca)^{-1}$ and the daily intake was 0.20 Bq ^{90}Sr or 5.3 pCi ^{90}Sr.

Table 3.2. Estimate of the mean content of ^{137}Cs in the human diet in Greenland in 1980

Type of food	Annual quantity in kg	Bq ^{137}Cs per kg	Total Bq ^{137}Cs	Percentage of total Bq ^{137}Cs in food
Milk and cream	78	0.111	8.66	2.4
Cheese	2.5	0.080	0.20	0.1
Grain products	95.6	0.26	24.86	6.9
Potatoes	32.8	0.077	2.52	0.7
Vegetables	5.5	0.084	0.46	0.1
Fruit	13.5	0.03	0.41	0.1
Meat and eggs	45.6	5.8	264.48	73.7
Fish	127.6	0.30	38.28	10.7
Coffee and tea	7.3	2.21	16.13	4.5
Drinking water	548	0.005	2.74	0.8
Total			358.74	

The mean annual potassium intake is estimated to be approx. 1.2 kg. Hence the $^{137}Cs/K$ ratio becomes 300 Bq ^{137}Cs (kg K)$^{-1}$ or 8.1 pCi ^{137}Cs (g K)$^{-1}$. The daily intake in 1980 from food was 0.98 Bq ^{137}Cs or 26.5 pCi ^{137}Cs.

3.9. Discussion

The most important ^{90}Sr source in the Greenland diet is still grain products, which contribute 52% of the total ^{90}Sr content in the diet. Milk products came next in importance, contributing 17%. Approx. 80% of the ^{90}Sr in the food consumed in Greenland in 1980 originated from imported Danish food.

Meat is still the most important ^{137}Cs source in the Greenland diet, contributing 74% of the total content in 1980. Approx. 85% of the ^{137}Cs in the Greenland diet in 1980 came from local products.

As compared with the 1979 figures, the ^{90}Sr contents in the total diet in 1980 was 14% lower than the 1979 level.

The ^{137}Cs level was 80% of the level found in 1979. As earlier discussed[1] the great variations from year to year are primarily due to the variations in the ^{137}Cs levels in the meat samples obtained.

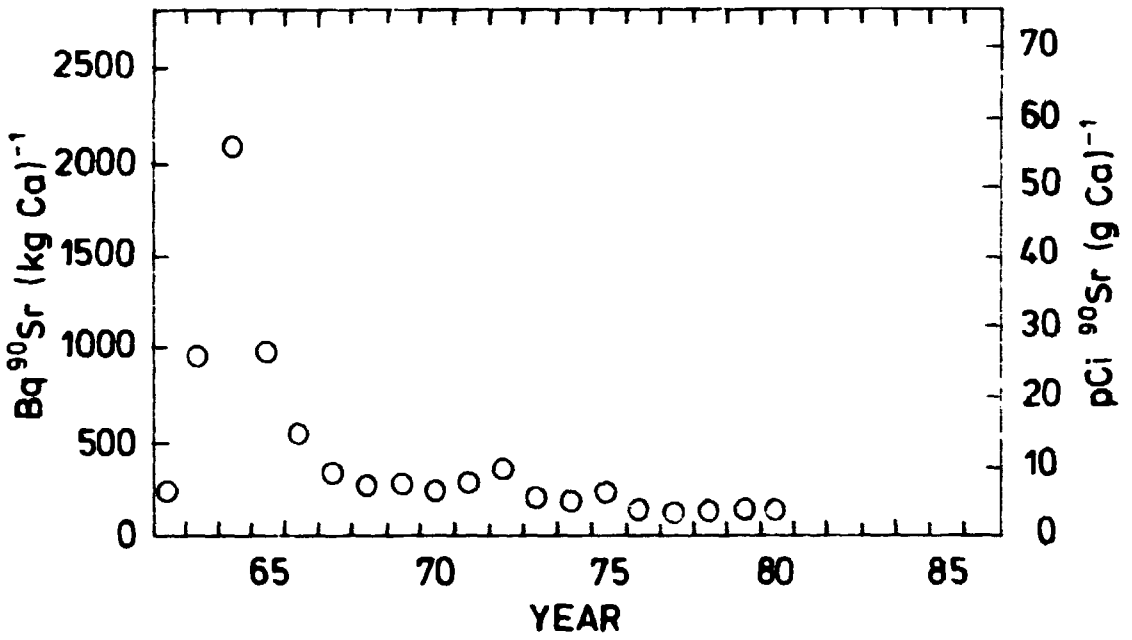

Fig. 3.1. Strontium-90 in Greenlandic diet, 1962-1980.

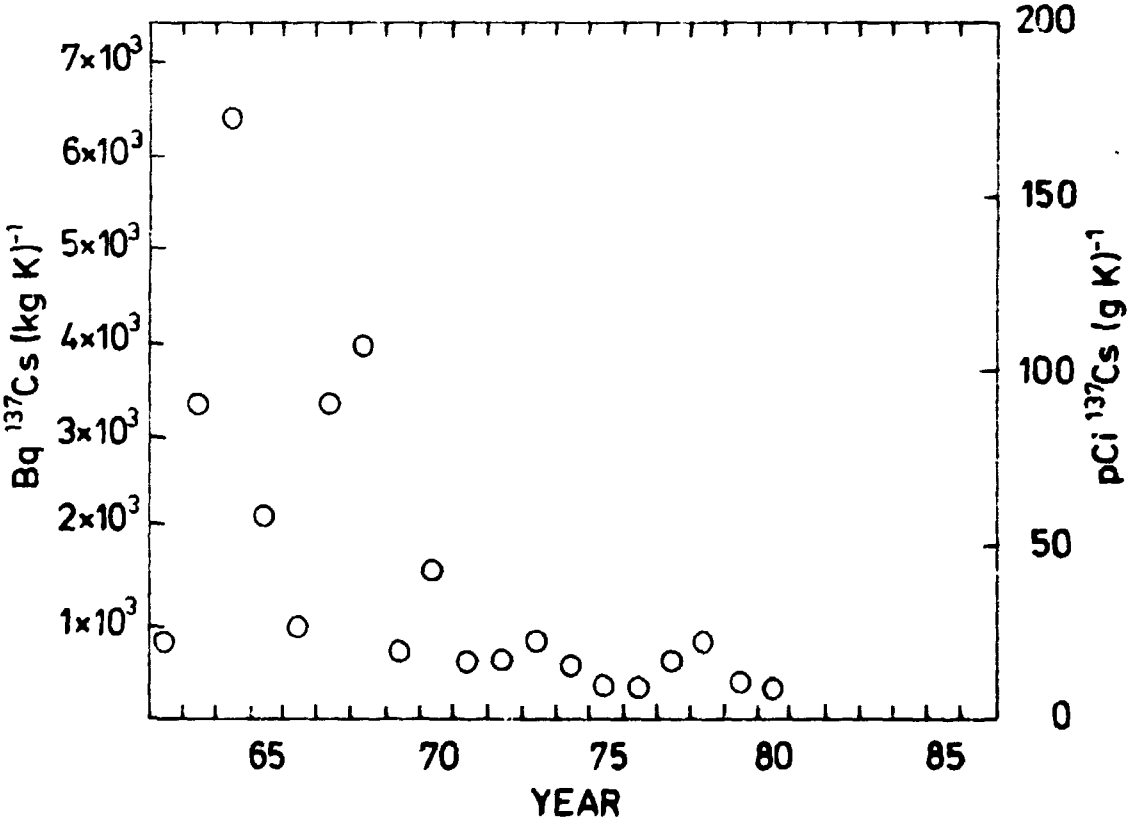

Fig. 3.2. Cesium-137 in Greenlandic diet, 1962-1980.

To estimate the maximum per capita intakes of ^{90}Sr and ^{137}Cs in Greenland in 1980 we assume[1] that the only grain product consumed by a person is dark rye bread, and that he only eats lamb meat. His daily intake of ^{90}Sr is thus 0.31 Bq (205 Bq ^{90}Sr (kg Ca)$^{-1}$) and his ^{137}Cs intake 5.6 Bq day^{-1} (using the quantities in Tables 3.1 and 3.2). At the lower limit we can imagine a person eating white bread and seal and drinking water with hardly any activity (e.g. water formed by the melting of old ice). In this case the daily intakes are 0.13 Bq ^{90}Sr (85 Bq ^{90}Sr (kg Ca)$^{-1}$) and 0.28 Bq ^{137}Cs. Hence the ratios between the levels in the maximum and minimum diets become 2 for ^{90}Sr and 20 for ^{137}Cs.

The ^{90}Sr content of the Greenland diet in 1980 was 82% of the estimated Danish mean content[2], and 63% of the Faroese level[3]. The ^{137}Cs level in the total diet in Greenland was 2.5 times that of the Danish diet and 20% of the Faroese diet level.

4. CONCLUSION

4.1.

The ^{90}Sr fallout rates in 1980 were the following: Godthåb: 4.7 Bq ^{90}Sr m^{-2}; Prins Chr. Sund: approx. 7.1 Bq ^{90}Sr m^{-2}; Upernavik: 3.7 Bq ^{90}Sr m^{-2}. The accumulated fallout levels by the end of 1980 were estimated at approx. 1050 Bq ^{90}Sr m^{-2} at Godhavn, 1300 Bq ^{90}Sr m^{-2} at Godthåb, 4600 Bq ^{90}Sr m^{-2} at Prins Chr. Sund, and 460 Bq ^{90}Sr m^{-2} at Upernavik.

4.2.

The food consumed in Greenland in 1980 contained on the average 129 Bq ^{90}Sr (kg Ca)$^{-1}$, and the daily mean intake of ^{137}Cs was estimated at 0.98 Bq. The most important ^{90}Sr contributors to the diet were grain products and milk products, together accounting for approx. 65% of the total ^{90}Sr content of the diet. Cesium-137 originated mainly from meat (reindeer and lamb) and fish, contributing approx. 85% of the total ^{137}Cs content of the diet.

4.3.

No ^{90}Sr analyses of human bone samples have hitherto been carried out on the population of Greenland. Considering the estimated ^{90}Sr levels in the diet, it seems probable[4], however, that the 1980 ^{90}Sr levels of humans in Greenland were on the average rather similar to those found in Denmark, i.e. the mean levels in human bone in Greenland were approx. 30 Bq ^{90}Sr (kg Ca)$^{-1}$ (vertebrae). From diet measurements the ^{137}Cs content in Greenlanders was estimated at 900 Bq ^{137}Cs (kg K)$^{-1}$.

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APPENDIX A

Thule sediments and sea water

Tables A.1-A.18 contain the provisional results of the plutonium, americium and ^{137}Cs analysis of Thule sediments collected in August 1979. Most of these data were presented in the 1979 report (Risø-R-423). However, the measurements performed at the locations V, X, Y which are those within 1 km from the point of impact have not been published earlier. Furthermore, all tables contain the Pu-levels in 3σ (shown in brackets). Tables A.19 and A.20 show the results of the sea water analyses.

Table A.1. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule. August 1979

Position	Unit	Depth section in cm					
A		0-3		3-6		6-9	
76°45'N 70°45'W	pCi $^{239,240}Pu$ kg^{-1}	32	(1.2)	26	(1.0)	169	(6.3)
Depth 144 m	(Bq kg^{-1})	61	(2.3)	39	(1.4)	22	(0.8)
	nCi $^{239,240}Pu$ m^{-2}	0.28	(10)	0.48	(18)	4.41	(163)
	(Bq m^{-2})	0.52	(19)	0.72	(27)	0.58	(21)
	$^{238}Pu/^{239,240}Pu$	0.053		-		0.020	
		0.044		-			
	$^{241}Am/^{239,240}Pu$	0.26		0.27			
		0.32					
	$^{239,240}Pu/^{137}Cs$	0.29		0.25		1.96	
		0.54		0.37		0.25	

No samples were obtained below 9 cm.

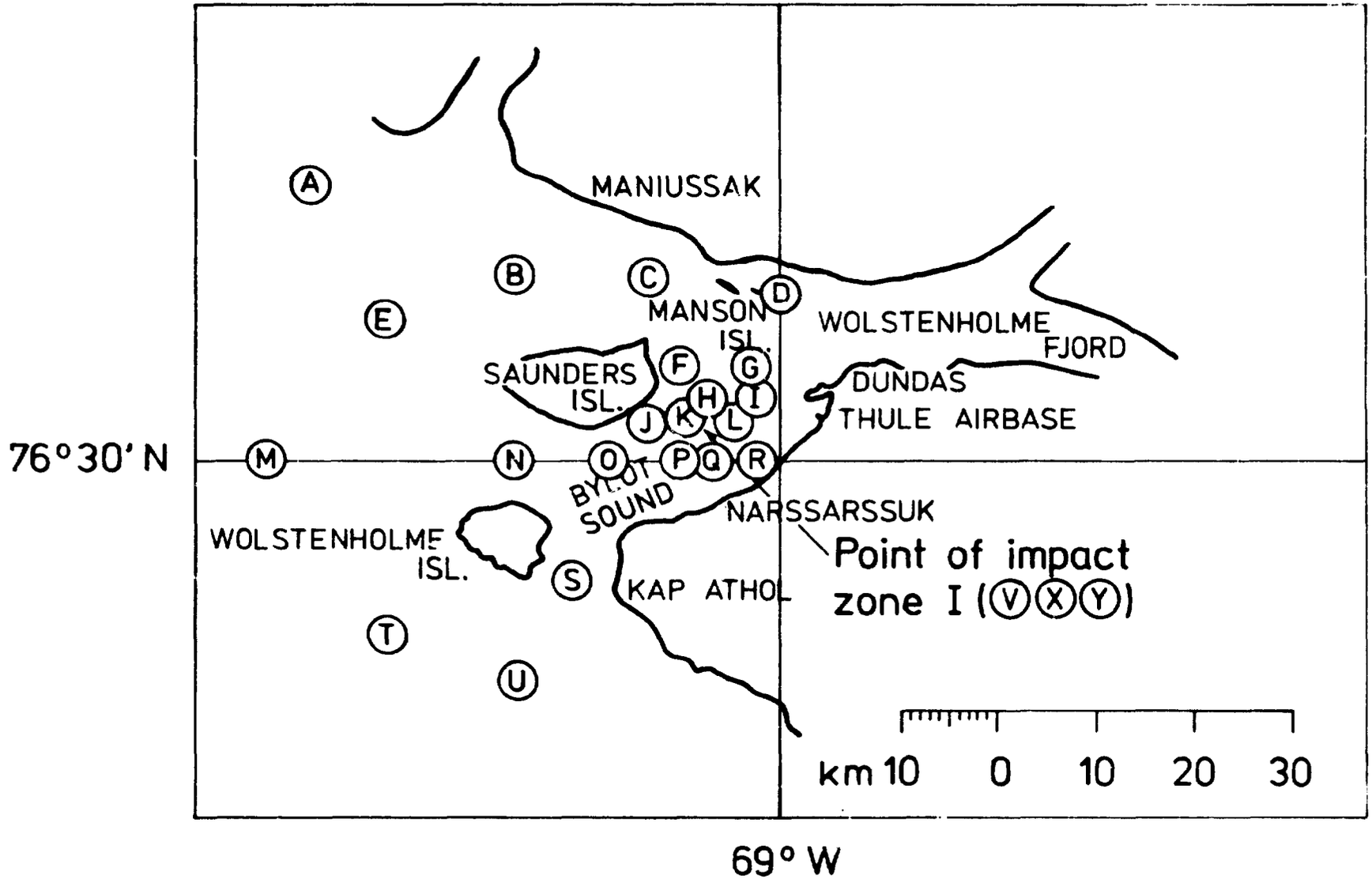

Fig. A.1. The sample locations at Thule.

Table A.2. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm		
B		0-3	3-6	6-9
76°40'N 70°00'W	pCi $^{239,240}Pu$ kg^{-1}	58 (2.1)	4.7 (0.2)	3.3 (0.1)
Depth 85 m	(Bq kg^{-1})	122 (4.5)	11 (0.4)	2.3 (0.09)
	nCi $^{239,240}Pu$ m^{-2}	0.62 (23)	0.10 (3.7)	0.084 (3.1)
	(Bq m^{-2})	1.31 (49)	0.24 (9)	0.059 (2.2)
	$^{238}Pu/^{239,240}Pu$	-	-	-
		-	-	-
	$^{241}Am/^{239,240}Pu$			
		0.09	0.11	0.27
	$^{239,240}Pu/^{137}Cs$	0.41	0.09	B.D.L.
		0.86	0.22	B.D.L.

No samples were obtained below 9 cm.

Table A.3. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm					
C(I)		0-3	3-6	6-9	9-12	12-15	15-18
76°40'N 69°30'W	pCi $^{239,240}Pu$ kg^{-1}	2069 (77)	474 (18)	387 (14)	95 (3.5)	41 (1.5)	10 (0.4)
Depth 110 m	(Bq kg^{-1})	668 (25)	295 (11)	206 (7.6)	70 (2.6)	28 (1.0)	13 (0.5)
	nCi $^{239,240}Pu$ m^{-2}	28.9 (1070)	10.4 (390)	8.4 (310)	2.2 (80)	1.02 (38)	0.24 (9)
	(Bq m^{-2})	9.3 (340)	6.5 (240)	4.5 (170)	1.6 (59)	0.70 (26)	0.31 (11.5)
	$^{238}Pu/^{239,240}Pu$	0.016	0.018	0.020	0.021		
		0.016	0.016	0.024	0.036		
	$^{241}Am/^{239,240}Pu$	0.10	0.12	0.16			
		0.14	0.18	0.13	0.12	0.25	
	$^{239,240}Pu/^{137}Cs$	6.10	1.57	1.93	0.82	0.97	B.D.L.
		1.97	0.98	1.02	0.60	0.66	B.D.L.

Table A.4. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm									
C(II)		0-3		3-6		6-9		9-12		12-15		15-18	
76°40'N 69°30'W	pCi $^{239,240}Pu$ kg^{-1}	1656	(61)	484	(18)	51	(1.9)	8.9	(0.3)	4.8	(0.2)	5.1	(0.2)
Depth 110 m	(Bq kg^{-1})	1600	(59)	195	(7.2)	45	(1.7)	3.9	(0.14)	7.3	(0.3)	3.0	(0.1)
	nCi $^{239,240}Pu$ m^{-2}	21.2	(785)	9.6	(355)	0.95	(35)	0.19	(7)	0.11	(4)	0.10	(4)
	(Bq m^{-2})	20.5	(760)	3.9	(145)	0.84	(31)	0.083	(3)	0.17	(6)	0.061	(2.3)
	$^{238}Pu/^{239,240}Pu$	0.018		0.021		0.043		-		-		-	
		0.013		0.024		0.027		-		-		-	
	$^{241}Am/^{239,240}Pu$	-		-		-							
		0.08		0.15		0.18							
	$^{239,240}Pu/^{137}Cs$	4.71		2.30		0.63		0.34		B.D.L.		B.D.L.	
		4.55		0.93		0.55		0.15		B.D.L.		B.D.L.	

Table A.5. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm									
D		0-3		3-6		6-9		9-12		12-15	
76°39'N 69°00'W	pCi $^{239,240}Pu$ kg^{-1}	147	(5.4)	8113	(300)	4.0	(0.15)	0.80	(0.03)	0.3	(0.01)
Depth 95 m	(Bq kg^{-1})	144	(5.3)	27	(1.0)	3.3	(0.1)	2.2	(0.08)	0.3	(0.01)
	nCi $^{239,240}Pu$ m^{-2}	2.11	(78)	198	(7300)	0.092	(3.4)	0.023	(0.9)	0.01	(0.4)
	(Bq m^{-2})	2.07	(77)	0.7	(26)	0.078	(2.9)	0.063	(2.3)	0.01	(0.4)
	$^{238}Pu/^{239,240}Pu$	0.018		0.014							
		0.019									
	$^{241}Am/^{239,240}Pu$	0.17		0.10		0.25					
		0.12		0.12							
	$^{239,240}Pu/^{137}Cs$	0.53		88.5		0.17		B.D.L.		B.D.L.	
		0.53		0.27		0.14					

No samples were obtained below 15 cm.

Table A.6. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm			
E		0-3	3-6	6-9	9-12
$76^{o}37'N$ $70^{o}30'W$	pCi $^{239,240}Pu$ kg^{-1}	18.9 (0.7)	8 7 (0.3)	2.7 (0.1)	B.D.L.
Depth 105 m	(Bq kg^{-1})	36 (1.3)	8.7 (0.3)	2.4 (0.09)	B.D.L.
	*)	28 (1.0)	13.4 (0.5)	5.4 (0.2)	3.9 (0.14)
	nCi $^{239,240}Pu$ m^{-2}	0.53 (20)	0.29 (11)	0.083 (3)	
	(Bq m^{-2})	1.02 (38)	0.29 (11)	0.074 (3)	
	*)	0.79 (29)	0.45 (17)	0.17 (6)	
	$^{238}Pu/^{239,240}Pu$	-	-	-	
		-	-	-	
	$^{241}Am/^{239,240}Pu$	0.16	0.17		
	*)	0.37	0.17		
	$^{239,240}Pu/^{137}Cs$	0.29	0.16	B.D.L.	B.D.L.
		0.55	0.17	B.D.L.	B.D.L.

*)Determinations carried out by Elis Holm, Lund, Sweden.

No samples were obtained below 12 cm.

Table A.7. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm					
G		0-3	3-6	6-9	9-12	12-15	15-18
76°35'N 69°05'W	pCi $^{239,240}Pu$ kg^{-1}	1141 (42)	637 (24)	135 (5)	86 (3.2)	33 (1.2)	3.7 (0.13)
Depth 187 m	(Bq kg^{-1})	1789 (66)	491 (18)	89 (3.3)	76 (2.8)	24 (0.9)	9.0 (0.3)
		898 (33)	424 (16)	88 (3.3)	68 (2.5)	19 (0.7)	2.9 (0.1)
	*)	1780 (66)	853 (32)	-	112 (4.1)	14 (0.5)	10 (0.4)
	nCi $^{239,240}Pu$ m^{-2}	9.7(360)	9.4(350)	2.30 (85)	1.68 (62)	0.63 (23)	0.085 (3)
	(Bq m^{-2})	15.1(560)	7.3(270)	1.51 (56)	1.48 (55)	0.46 (17)	0.209 (8)
		7.6(280)	6.3(230)	1.50 (56)	1.32 (49)	0.36 (13)	0.067(2.5)
	*)	15.0(560)	12.7(470)	-	2.18 (81)	0.27 (10)	0.23 (9)
	$^{238}Pu/^{239,240}Pu$	0.014	0.017	0.040	0.016	0.036	
		-	-	-			
		0.022	0.025	0.041			
	*)	0.017	0.018	-	0.044		
	$^{241}Am/^{239,240}Pu$	0.12	0.12	0.16	0.10		
		0.13	0.12	0.17	0.12		
	*)	0.12	0.11	-	0.23	0.14	0.17
	$^{239,240}Pu/^{137}Cs$	3.46	2.35	1.48	3.66	3.15	B.D.L.
		5.39	1.81	0.97	3.22	2.29	B.D.L.
		2.70	1.57	0.96	2.87	1.80	B.D.L.

*)Determinations carried out by Elis Holm, Lund, Sweden.

Table A.8. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm				
H		0-3	3-6	6-9	9-12	12-15
76°33'N 69°17'W	pCi $^{239,240}Pu$ kg^{-1}	3772 (140)	1272 (47)	2962 (110)	2170 (80)	4184 (155)
Depth 180	(Bq kg^{-1})	1941 (72)	1601 (59)	1887 (70)	2218 (82)	3781 (140)
	nCi $^{239,240}Pu$ m^{-2}	70 (2600)	28.1 (1040)	63.5 (2400)	55.7 (2060)	90 (3300)
	(Bq m^{-2})	36 (1330)	35 (1300)	40 (1500)	57 (2100)	81 (3000)
	$^{238}Pu/^{239,240}Pu$	0.018	0.017	0.014	0.014	0.012
		0.015	0.014	0.015	0.012	0.012
	$^{241}Am/^{239,240}Pu$	0.11	0.096	0.11	0.091	
		0.10	0.13	0.13	0.08	0.08
	$^{239,240}Pu/^{137}Cs$	15.02	5.89	10.23	10.02	21.09
		7.73	7.41	6.52	10.24	19.05

No samples were obtained below 15 cm.

Table A.9. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm					
I		0-3	3-6	6-9	9-12	12-15	15-18
76°33'N 69°07'W	pCi $^{239,240}Pu$ kg^{-1}	754 (28)	6258 (230)	34 (1.2)	4.4 (0.16)	1.76(0.07)	12.4 (0.5)
Depth 185 m	(Bq kg^{-1})	7556 (280)	581 (22)	50 (1.9)	5.5 (0.2)	13 (0.5)	2.2 (0.08)
	nCi $^{239,240}Pu$ m^{-2}	12.1(450)	197 (7300)	0.99 (37)	0.14 (5.2)	0.06 (2)	
	(Bq m^{-2})	121 (4500)	18.3(680)	1.46 (54)	0.18 (6.7)	0.44 (16)	
	$^{238}Pu/^{239,240}Pu$	0.017	0.012	0.029			
		0.0095	0.0036				
	$^{241}Am/^{239,240}Pu$	0.080	0.077	0.14			
		0.045	0.13	0.16	0.24		
	$^{239,240}Pu/^{137}Cs$	2.03	27.20	0.58	0.15	B.D.L.	0.87
		20.38	2.52	0.86	0.19	B.D.L.	0.16

Table A.10. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm		
J		0-3	3-6	6-9
76°32'N 69°30'W	pCi $^{239,240}Pu$ kg^{-1}	213 (7.9)	238 (46)	901 (33)
Depth 90 m	(Bq kg^{-1})	323 (12.0)	325 (12)	145 (5.4)
	nCi $^{239,240}Pu$ m^{-2}	4.5 (170)	7.5 (280)	33.3 (1230)
	(Bq m^{-2})	6.8 (250)	10.2 (380)	5.4 (200)
	$^{238}Pu/^{239,240}Pu$	0.022	0.022	0.012
		0.014	0.017	0.020
	$^{241}Am/^{239,240}Pu$	0.11	0.080	0.064
		0.14	0.11	0.11
	$^{239,240}Pu/^{137}Cs$	2.23	1.94	9.45
		3.38	2.65	1.52

No samples were obtained below 9 cm.

Table A.11. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm				
K		0-3	3-6	6-9	9-12	12-15
76°32'N 69°20'W	pCi $^{239,240}Pu$ kg^{-1}	2114 (78)	1491 (55)	1740 (64)	3626 (134)	786 (29)
Depth 190 m	(Bq kg^{-1})	2797 (104)	2090 (77)	728 (27)	616 (23)	885 (33)
	nCi $^{239,240}Pu$ m^{-2}	28.0 (1040)	34.8 (1300)	44.6 (1650)	100.9 (3700)	13.5 (500)
	(Bq m^{-2})	37.0 (1370)	48.8 (1810)	18.7 (690)	17.1 (630)	15.2 (560)
	$^{238}Pu/^{239,240}Pu$	0.015	0.019	0.013	0.012	0.018
		0.030	0.012	0.015	0.015	0.023
	$^{241}Am/^{239,240}Pu$	0.11	0.098	0.069	0.062	0.11
		0.10	0.12	0.14	0.14	0.10
	$^{239,240}Pu/^{137}Cs$	9.38	9.56	23.80	69.97	7.63
		12.41	13.40	9.96	11.89	8.59

No samples were obtained below 15 cm.

Table A.12. Plutonium and Americium in marine sediments collected with a 145 cm² corer in Thule, August 1979

Position	Unit	Depth section in cm				
L		0-3	3-6	6-9	9-12	12-13.5
76°32'N 69°10'W	pCi $^{239,240}Pu$ kg^{-1}	6327 (230)	372 (14)	182 (6.7)	27 (1.0)	373 (14) (surf.cont.)
Depth 123 m	(Bq kg^{-1})	1122 (42)	1470 (54)	234 (8.7)	32 (1.2)	48 (1.8)
	nCi $^{239,240}Pu$ m^{-2}	196 (7300)	11.5 (430)	5.5 (200)	0.92 (34)	-
	(Bq m^{-2})	35 (1300)	45.4 (1680)	7.1 (260)	1.10 (41)	
	$^{238}Pu/^{239,240}Pu$	0.013	0.014	0.023		0.020
		0.031	0.013	0.022		0.023
	$^{241}Am/^{239,240}Pu$	0.083	0.12	0.12	0.070	0.12
		0.13	0.074	0.11	0.091	
	$^{239,240}Pu/^{137}Cs$	28.6	3.25	4.75	B.D.L.	26.0
		5.04	12.84	6.11	B.D.L.	3.35

No samples were obtained below 13.5 cm.

Table A.13. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm	
O		0-3	3-6
76°30'N 69°40'W	pCi $^{239,240}Pu$ kg^{-1}	1469 (54)	255 (95)
Depth 110 m	(Bq kg^{-1})	232 (8.6)	399 (15)
	nCi $^{239,240}Pu$ m^{-2}	31.9 (1180)	91.9 (3400)
	(Bq m^{-2})	5.0 (185)	14.3 (530)
	$^{238}Pu/^{239,240}Pu$	0.017	0.015
		0.016	0.019
	$^{241}Am/^{239,240}Pu$	0.13	0.090
		0.16	0.15
	$^{239,240}Pu/^{137}Cs$	13.5	23.6
		2.12	3.7

No samples were obtained below 6 cm.

Table A.14. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm					
P		0-3	3-6	6-9	9-12	12-15	15-17
76°30'N 69°25'W	pCi $^{239,240}Pu$ kg^{-1}	83447 (3090)	521 (19)	123 (4.6)	67 (2.5)	448 (17)	359 (13)
Depth 235 m	(Bq kg^{-1})	978 (36)	619 (23)	145 (5.4)	80 (3.0)	156 (5.8)	1569 (58) (surf.cont.)
	nCi $^{239,240}Pu$ m^{-2}	1390 (51500)	10.2 (380)	2.72 (100)	1.41 (52)	11.1 (410)	5.6 (207)
	(Bq m^{-2})	16 (590)	12.2 (450)	3.2 (120)	1.68 (62)	3.9 (140)	24 (890)
	$^{238}Pu/^{239,240}Pu$	0.018	0.014			0.017	0.009
		0.015	0.019	0.011			0.014
	$^{241}Am/^{239,240}Pu$	0.097	0.11	0.26	0.15	0.096	0.14
		0.12	0.18	0.10	0.08	0.15	0.08
	$^{239,240}Pu/^{137}Cs$	218	1.83	1.42	1.3	6.4	3.4
		2.55	2.17	1.67	1.55	2.23	14.9

Table A.15. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm		
R		0-3	3-6	6-9
76°30'N 69°10'W	pCi $^{239,240}Pu$ kg^{-1}	69 (2.6)	30 (1.1)	9.9 (0.4)
Depth 70 m	(Bq kg^{-1})	61 (2.3)	19 (0.7)	11 (0.4)
	nCi $^{239,240}Pu$ m^{-2}	1.76 (65)	1.18 (44)	0.43 (16)
	(Bq m^{-2})	1.56 (58)	0.75 (28)	0.48 (18)
	$^{238}Pu/^{239,240}Pu$	-	-	-
	$^{241}Am/^{239,240}Pu$		0.11	0.25
			0.26	
	$^{239,240}Pu/^{137}Cs$	1.11	0.70	0.39
		0.98	0.44	0.43

No samples were obtained below 9 cm.

Table A.16. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm					
V		0-3	3-6	6-9	9-12	12-15	15-18
76°31'3N 69°17'4W	pCi $^{239,240}Pu$ kg^{-1}	79400 (2940)	14300 (530)	5300 (200)	3600 (130)	4900 (180)	1360 (50)
Depth 180 m	(Bq kg^{-1})	5500 (200)	24200 (900)	7200 (270)	4000 (150)	3300 (120)	380 (14)
	nCi $^{239,240}Pu$ m^{-2}	1135 (42000)	281 (10400)	116 (4300)	88 (3300)	132 (4900)	32 (1200)
	(Bq m^{-2})	79 (2900)	476 (17600)	158 (5900)	97 (3600)	90 (3300)	9 (330)
	$^{238}Pu/^{239,240}Pu$	0.013	0.014	0.017	0.014	0.016	0.015
		0.018	0.020	0.016	0.015	0.014	0.014
	$^{241}Am/^{239,240}Pu$	0.050	0.062	0.151	0.11	0.094	0.098
		0.081	0.065	0.074	0.082	0.083	0.098
	$^{239,240}Pu/^{137}Cs$	285	56	24	25	51	30
		20	94	33	28	35	8.4

Table A.17. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm					
X		0-3	3-6	6-9	9-12	12-15	15-18
76°31'5N 69°15'8W	pCi $^{239,240}Pu$ kg^{-1}	5700 (210)	4800 (180)	6400 (240)	4800 (180)	1280 (47)	1280 (47)
Depth 180 m	(Bq kg^{-1})	4300 (160)	3200 (120)	1840 (68)	1140 (42)	2350 (87)	670 (25)
	nCi $^{239,240}Pu$ m^{-2}	59 (2200)	94 (3500)	131 (4900)	108 (4000)	32 (1190)	24 (890)
	(Bq m^{-2})	45 (1700)	63 (2300)	38 (1400)	26 (960)	59 (2200)	12 (440)
	$^{238}Pu/^{239,240}Pu$	0.016	0.015	0.012	0.021	0.016	0.014
		0.014	0.017	0.017	0.015	0.018	0.016
	$^{241}Am/^{239,240}Pu$	0.082	0.100	0.123	0.116	0.19	0.092
		0.089	0.090	0.115	0.120	0.060	0.094
	$^{239,240}Pu/^{137}Cs$	21.2	23.2	29.6	20.1	4.7	5.4
		16.2	15.5	8.5	4.8	9.1	2.8

Table A.18. Plutonium and Americium in marine sediments collected with a 145 cm^2 corer in Thule, August 1979

Position	Unit	Depth section in cm					
Y		0-3	3-6	6-9	9-12	12-15	15-18
76°31'N 69°18'5W	pCi $^{239,240}Pu$ kg^{-1}	7300 (270)	2900 (110)	496 (18)	88 (3.3)	9.3 (0.3)	9.2 (0.3)
Depth 220 m	(Bq kg^{-1})	6000 (240)	6700 (250)	650 (24)	250 (9.3)	7.7 (0.3)	150 (5.6)
	mCi $^{239,240}Pu$ m^{-2}	115 (4300)	59 (2200)	10.6(390)	2.2(81)	0.25 (9.3)	0.17 (6.3)
	(Bq m^{-2})	100 (3750)	136 (5000)	14.1(520)	4.2(230)	0.21 (7.8)	11.0 (410)
	$^{238}Pu/^{239,240}Pu$	0.017	0.018	-	- *	- *	- *
		0.017	0.016	0.017	0.022	-	0.016
	$^{241}Am/^{239,240}Pu$	0.085	0.19		0.14		0.34
		0.135	0.060	0.073	0.11		0.104
	$^{239,240}Pu/^{137}Cs$	21.5	8.5	10.4	-	-	-
		78.7	28.4	13.8			

*Traces of Th?

Table A.19. Plutonium and Americium in sea water collected in Thule, August 1979

Position	Unit	Sample depth	Total water	Filtered water (0.45 µ)	Particulate activity
E + M	fCi $^{239/240}Pu$ l^{-1} (Bq m^{-3})		0.48 (0.018)	0.40 (0.014)	
76°37'N 70°30'W	$^{238}Pu/^{239,240}Pu$	Surface			
76°30'N 70°55'W	$^{241}Am/^{239,240}Pu$				
	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})		0.54 (0.020)	0.88 (0.033)	0.08 (0.003)
76°43'N 73°00'W	$^{238}Pu/^{239,240}Pu$	Surface	-	0.023	-
(Analysed by Elis Holm, Lund)	$^{241}Am/^{239,240}Pu$		0.19	0.13	0.63
	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})		0.55 (0.020)		
76°33'N 69°35'W	$^{238}Pu/^{239,240}Pu$	Surface	0.055		
(Analysed by Elis Holm, Lund)	$^{241}Am/^{239,240}Pu$		0.27		
L	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})		0.49 (0.018)		
76°32'N 69°10'W	$^{238}Pu/^{239,240}Pu$	Surface	-		
	$^{241}Am/^{239,240}Pu$		0.063		

Table A.20. Plutonium and Americium in sea water collected in various depths at the point of impact: W: 76°31'E, 69°18'5N in Thule, August 1979

Sample depth in metres	Unit	Total water	Filtered water 0.45 μ	Particulate activity
Surface	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})		0.31 (0.012)	0.030 (0.011)
	$^{238}Pu/^{239,240}Pu$			
	$^{241}Am/^{239,240}Pu$		0.079	0.20
50	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})	0.57 (0.021)		
	$^{238}Pu/^{239,240}Pu$			
	$^{241}Am/^{239,240}Pu$			
100	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})	0.42 (0.016)		
	$^{238}Pu/^{239,240}Pu$			
	$^{241}Am/^{239,240}Pu$			
150	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})	0.53 (0.020)		
	$^{238}Pu/^{239,240}Pu$			
	$^{241}Am/^{239,240}Pu$	~0.19		
170 (near bottom)	fCi $^{239,240}Pu$ l^{-1} (Bq m^{-3})	1.82 (0.067)	estimated 1.82-1.42 = 0.4 (0.014)	1.42 (0.053)
	$^{238}Pu/^{239,240}Pu$			
	$^{241}Am/^{239,240}Pu$	0.060		0.12

APPENDIX B

Biological samples from Thule

Tables B.1-B.18 show the provisional results of the plutonium and americium analysis on benthic animals collected at Thule in August 1979. Table B.19 presents the data on sea plants and Table B.20-B.23 show analysis of fish, sea birds, marine mammals and terrestrial samples respectively.

Table B.1. Plutonium and Americium in benthos collected at Thule, August 1979, at location: Carey Islands 76°43'N 73°00'W, 98 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	1.9	0.070			17
Macoma shell	6.8	0.25			95
Brittlestars	~0	~0			53

Table B.2. Plutonium and Americium in benthos collected at Thule, August 1979, at location: B 76°40'N 70°00'W, 24 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	2.1	0.078			18
Macoma shell	22 21	0.81 0.78	-		85
Hiatella shell	< 2	< 0.07			
Chlinocardium flesh	1.66	0.062			19
Chlinocardium shell	3.5	0.13			80
Brittlestars	< 3 5.7	< 0.1 0.21			
Seaurchin	5.0	0.19	0.051	0.13	
Worms flesh	14 1.8	0.52 0.065			24 3.3
Worms shell	47	1.74	0.026		59

Table B.3. Plutonium and Americium in benthos collected at Thule, August 1979, at location: C 76°40'N 69°30'W, 17 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma shell	69	2.56	0.019	0.19	
Brittlestars	61	2.26			
Worms flesh	66	2.44			36

Table B.4. Plutonium and Americium in benthos collected at Thule, August 1979, at location: D 76°39'N 69°00'W, 16 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	7.2	0.27	0.036		15
Macoma shell	16.3	0.60		0.27	

Table B.5. Plutonium and Americium in benthos collected at Thule, August 1979, at location: E 76°37'N 70°30'W, 33 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	1.9	0.070			21
Macoma shell	5.6	0.21			82
Brittlestars	4.1	0.15			
Sea anemone	0.84				

Table B.6. Plutonium and Americium in benthos collected at Thule, August 1979, at location: F 76°35'N 69°25'W, 7 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	16.7	0.62	0.014		18
Macoma shell	68	2.52	0.029		79
Chlamys flesh	5.6	0.21	0.016		20
	1.6	0.06			58
Chlamys shell	29	1.07	0.029		97
	86	3.19	0.018		93
Hiatella flesh	80	2.96	0.014		18
	2.5	0.09	-		22
Hiatella shell	6.0	0.22			91
	8.1	0.30			85
Musculus shell	3.1	0.11			69
	10.3	0.38			67
Chlinocardium flesh	3.6	0.13	0.016		19
Chlinocardium shell	22	0.81			90
Astarte shell	49	1.81	0.016		93 borealis
	73	2.70	0.026		(86)95 montagne
	20	0.74			
Serripes flesh	3.1	0.11			21
Serripes shell	14	0.52			94
Sea urchin	11.2	0.41			33
Balanus shell	16.7	0.62			75
Coral	19.4	0.72			71
Bryozoa	18	0.67	0.021		19
Spongia	7.4	0.27	0.020		11
Worms flesh	15	0.56	0.024		27
Worms shell	68	2.52	0.016		53

Table B.7. Plutonium and Americium in benthos collected at Thule, August 1979, at location: G 76°35'N 69°05'W, 9 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma shell	39	1.07			60

Table B.8. Plutonium and Americium in benthos collected at Thule, August 1979, at location: H 76°33'N 69°17'W, 3 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	153	5.7	0.015		20
Macoma shell	315	11.7	0.019	0.15	

Table B.9. Plutonium and Americium in benthos collected at Thule, August 1979, at location: I 76°33'N 69°07'W, 5.5 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	23	0.85	0.026		17
Macoma shell	24	0.89		0.26	
Brittlestars	11.7	0.43			
Worms flesh	670	25	0.014		26

Table B.10. Plutonium and Americium in benthos collected at Thule, August 1979, at location: K 76°32'N 69°20'W, 1.7 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	6.2	0.23	0.013		
Macoma shell	329	12.2	0.022	0.18	
Brittlestars	57	2.11			

Table B.11. Plutonium and Americium in benthos collected at Thule, August 1979, at location: N 76°30'N 70°00'W, 19 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Brittlestars	< 10	< 0.4			
Sea urchin	5.9	0.22			
Bryozoa	9.9	0.37	0.032		25
Sea scorpion	27	1.00			

Table B.12. Plutonium and Americium in benthos collected at Thule, August 1979, at location: O 76°30'N 69°40'W, 10 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	17.7	0.66	0.020		18
Macoma shell	58	2.15	0.024		82
Hiatella flesh	21	0.78	0.019		17
Hiatella shell	66	2.44	0.023		89
Museulus shell					78
Chlinocardium flesh	8.4	0.31	0.018		17
Chlinocardium shell	21	0.78	0.024		88
Astarte shell	14 37	0.52 1.37			90 borealis 88 montagne
Serripes shell	16	0.59			90
Sea urchin	12.7	0.47	0.014		30
Chrinoidea	1.74	0.064			39
Coral	13.3	0.49	0.018		21
Worms flesh	720	27	0.017		36

Table B.13. Plutonium and Americium in benthos collected at Thule, August 1979, at location: P 76°30'N 69°25'W, 4 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	29	1.07	0.024		13
Macoma shell	169	6.3	0.082	0.10	
Chlinocardium flesh	12	0.44	0.021		12
Chlinocardium shell	68	2.52		0.30	

Table B.14. Plutonium and Americium in benthos collected at Thule, August 1979, at location: Q 76°30'N 69°15'W, 3 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Brittlestars	24	0.89			

Table B.15. Plutonium and Americium in benthos collected at Thule, August 1979, at location: R 76°30'N 69°10'W, 4 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma shell	25	0.93			76
Brittlestars	18.5 2.5	0.69 0.09			46
Sea urchin	5.6 7.1	0.21 0.26	0.028	0.16	29
Coral	10.2	0.38			75
Sea anemone	0.61	0.023			11
Crinoidea					50
Bryozo	11	0.41			16
Solaster sp.	4.6	0.09		0.44	
Worms flesh	19	0.70	0.011		22

Table B.16. Plutonium and Americium in benthos collected at Thule, August 1979, at location: V 76°31'3N 69°17'4W: point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	114 133	4.2 4.9	0.017 0.012	0.17 0.21	20
Macoma shell	473 467	17.5 17.3	0.021 0.016	0.18 0.12	38
Hiatella flesh	242	9.0	0.013	0.18	20
Hiatella shell	134 147	5.0 5.4	0.027 0.019	0.27 0.34	84
Musculus flesh	18	0.67	0.026		22
Musculus shell	28	1.04			95
Brittlestars	214 245	7.9 9.1	0.013 0.018	0.084 0.109	46
Coral	911 9010	34 330	0.012 0.012	0.088 0.096	56
Worms flesh	586	22	0.017	0.13	22
Worms shell	980 1110	36 41	0.017 0.018	0.12 0.11	45

Table B.17. Plutonium and Americium in benthos collected at Thule, August 1979, at location: X 76°31'5N 69°15'8W: 0.8 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	506	18.7	0.010	0.23	21
Macoma shell	572	21	0.016	0.19	96
Hiatella flesh	53	1.96	0.025		16
Hiatella shell	327 288	12.1 10.7	0.012 0.016	0.16 0.21	90
Worms flesh	230	8.5	0.015	0.098	30

Table B.18. Plutonium and Americium in benthos collected at Thule, August 1979, at location: Y 76°31'N 69°18'5W: 0.8 km from point of impact

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Macoma flesh	386	14.3	0.015	0.17	18
Macoma shell	1290 1140	48 42	0.014 0.017	0.14 0.16	83
Musculus flesh	180	6.7	0.019		16
Musculus shell	400	15.0	0.015	0.28	77

Table B.19. Plutonium and Americium in brown algae collected at Thule, August 1979

Position	Unit	Species and plant part					
		Fucus total plant		Laminaria leaves		Laminaria stems	
76°43'N 73°00'W	pCi ^{239,240}Pu kg^{-1} dry	14.6,	16.7*	3.0		3.4	
tidal zone	(Bq kg^{-1})	(0.54)	(0.62)	(0.11)		(0.13)	
	^{238}Pu/^{239,240}Pu		0.051*				
	^{241}Am/^{239,240}Pu	0.043					
76°43'N 73°00'W	pCi ^{239,240}Pu kg^{-1} dry			6.8,	11.3*	4.9,	5.3*
8 m depth	(Bq kg^{-1})			(0.25)	(0.42)	(0.18)	(0.20)
	^{238}Pu/^{239,240}Pu				0.040*		
	^{241}Am/^{239,240}Pu				0.088*	0.13	
76°34'N 68°50'W	pCi ^{239,240}Pu kg^{-1} dry	7.7,	7.6*				
tidal zone	(Bq kg^{-1})	(0.29)	(0.28)				
	^{238}Pu/^{239,240}Pu						
	^{241}Am/^{239,240}Pu						
76°45'N 69°55'W	pCi ^{239,240}Pu kg^{-1} dry	7.8		5.7		6.5	
tidal zone	(Bq kg^{-1})	(0.29)		(0.21)		(0.24)	
	^{238}Pu/^{239,240}Pu						
	^{241}Am/^{239,240}Pu						
76°27'N 69°21'5W	pCi ^{239,240}Pu kg^{-1} dry					3.24	
5 m depth	(Bq kg^{-1})					(0.12)	
	^{238}Pu/^{239,240}Pu						
	^{241}Am/^{239,240}Pu						
76°27'N 69°21'5W	pCi ^{239,240}Pu kg^{-1} dry			1.64		2.00	
tidal zone	(Bq kg^{-1})			(0.061)		(0.074)	
	^{238}Pu/^{239,240}Pu						
	^{241}Am/^{239,240}Pu						

*Samples analysed by Elis Holm, Lund, Sweden.

Table B.20. Plutonium and Americium in marine fish collected at Thule, August 1979

Sample		pCi $^{239,240}Pu$ kg^{-1}	Bq $^{239,240}Pu$ kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
		fresh weight				
Sea scorpion $76^{o}33'N$ $69^{o}35'W$	meat	0.043	0.0016		0.13	
	roe	B.D.L.				
	liver	B.D.L.				
	bone	0.41	0.015			
Sea scorpion $76^{o}33'N$ $68^{o}50'W$	meat	B.D.L.				
	bone	B.D.L.				
Sea scorpion $^{7}6^{o}27'N$ $69^{o}21'5W$	total	0.14	0.005			22
Polar cod R	total	1.74	0.065			20

Table B.21. Plutonium and Americium in marine birds collected at Thule, August 1979

Sample		pCi $^{239,240}Pu$ kg^{-1}	Bq $^{239,240}Pu$ kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
		fresh weight				
Guillemot Maniussak	2 birds: meat	0.092	0.0034			
	2 birds: bone	B.D.L.				
	5 birds: liver	1.5	0.054			
	3 birds: meat	B.D.L.				
	3 birds: bone	B.D.L.				
Eider Maniussak	meat	B.D.L.				
	2 birds: bone	1.5	0.057		0.24	
	5 birds: liver	0.065	0.0024			29

Table B.22. Plutonium and Americium in marine mammals shot at Thule in March-April 1980

Sample		pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
Seal (4/3-80) (North of Saunders Isl.)	meat	B.D.L.				
	liver	0.075	0.0028		B.D.L.	52
	kidney	B.D.L.				
	bone	B.D.L.				57
Seal (1/3-80) (North of Saunders Isl.)	meat	B.D.L.				42
	liver	B.D.L.				43
	bone	B.D.L.				70
Seal (5/4-80) (South of Saunders Isl.)	meat	B.D.L.				37
	liver	B.D.L.				39
	bone	B.D.L.				70
Seal (5/4-80) (South of Saunders Isl.)	- -	B.D.L.				42
	bone	B.D.L.				65
Whalros (5/4-80) (West of Saunders Isl.)	meat	B.D.L.				29
	liver	0.028	0.0010			35
	bone	B.D.L.				41
Whalros (10/4-80) (West of Saunders Isl.	meat	B.D.L.				33
	liver	0.16±0.01	0.0059		0.65	31
	bone	B.D.L.				49
Whalros (15/3-80) (West of Saunders Isl.)	meat	B.D.L.				29
	liver	0.033	0.0012			31
	bone	B.D.L.				67
Whalros (10/4-80) (West of Saunders Isl.	meat	B.D.L.				32
	liver	lost				40
	bone	B.D.L.				49

B.D.L.: bone < 1 pCi kg^{-1} fresh weight

B.D.L.: meat < 0.1 pCi kg^{-1} fresh weight.

Table B.23. Plutonium and Americium in terrestrial samples collected at Thule, August 1979

Sample	pCi $^{239,240}Pu$ kg^{-1} fresh weight	Bq $^{239,240}Pu$ kg^{-1} fresh weight	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	% dry matter
100 l stream water Narssarssuk 76°27'N 69°21'5W	$0.71 \cdot 10^{-3}$	$0.026 \cdot 10^{-3}$	0.067	0.15	
Cetraria nivalis Carey Islands 76°43'N 73°00'W	13.7	0.51	0.060	0.41	31
	16.3	0.60	0.058		31
Cetraria nivalis Saunders Island 1.3 m^2 $^{239,240}Pu$: 0.72 nCi m^{-2} = 26.7 Bq m^{-2}	530	19.6	0.016	0.12	28
	590	21.9	0.017	0.11	28
Cetraria nivalis Narssarssuk 0.34 m^2 $^{239,240}Pu$: 2.00 nCi m^{-2} = 74 Bq m^{-2}	760	28.2	0.015	0.091	39
	895	33.2	0.018		39

APPENDIX C

Biomass in Thule sediments

During the Thule expedition in August 1979 the biomass of benthic organisms were determined at 10 locations. The mean depth of the 10 locations was 167±52 (1 S.D.) m.

Table C.1. Biomass (soft tissue) of benthos determined at Thule, August 1979 at locations B, C, D, K, H, G, P, I, X, Y (0.1 m^2 sampled by van Veen sampler at each of the ten locations)

Species	Number per m^2 ±1 S.E.	Fresh weight in g m^{-2} ±1 S.E.	% of total weight
Macoma calcarea	176±35	97.3±18.1	38
Clinocardium ciliatum	13±6	50.8±25.2	20
Hiatella striata	5±3	7.2±3.8	3
Brittlestars	10±3	17.8±7.4	7
Worms	~240±60	70.4±34.6	27
Leda sp.	5±3	1.7±1.0	1
Crustacea	24±21	6.9±6.7	3
Nucula sp.	1±1	0.1±0.1	0
Musculus niger	5±3	3.9±2.3	1
Mya truncata	1±1	0.3±0.3	0
Total		256.4	

APPENDIX D

Preliminary results from the Swedish YMER 1980 expedition

In June-September 1980 Professor Bertil Persson and Dr. Elis Holm, Lund University, participated in the Swedish scientific YMER expedition to Spitzbergen and NE-Greenland. A number of samples collected at this expedition have been analysed by Risø as a part of the current cooperation between Lund University and Risø. The provisional results are presented in Tables D.1 (sea water) and D.2 (biota). The data will form part of the EEC-funded radioecological studies of the North Atlantic Region (BIO/B-339-DK(G)).

Table D.1. Plutonium, Americium and radiocesium in sea water samples collected by the Swedish YMER expedition to Spitsbergen - NE Greenland in June-September 1980

Position	Sample depth in m	Date	$^{239,240}Pu$ fCi l^{-1}	$^{239,240}Pu$ Bq m^{-3}	^{137}Cs pCi l^{-1}	^{137}Cs Bq m^{-3}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	$^{134}Cs/^{137}Cs$	Salinity in o/oo	Sample size in litres	YMER number
69.3°N 15.0°E	0	29 June 1980	0.23	0.0086			0.18	0.061			filter 2000	6
71.2°N 14.2°E	0	3 July 1980	0.23	0.0086			0.10	-			filter 2137	7
78.8°N 29.2°E	0	6 July 1980	0.037	0.0014			0.11	-			filter 2204	8
80.5°N 24.9°E	0	10 July 1980	0.038	0.0014				0.17			filter 1861	9
80.5°N 22.9°E	0	11 July 1980	0.036	0.0013			0.055	0.23			filter 4776	10
81.4°N 23.2°E	0	13 July 1980	0.049	0.0018				0.23			filter 1247	11
81.4°N ~24°E	0	- " -	0.16f	0.0061			0.062	0.16			filter 4439	12
82.3°N 25.3°E	0	15 July 1980	0.144	0.0053			0.043	0.12			filter 3420	13
81.8°N 26.6°E	0	17 July 1980	0.19	0.0070			-	-			filter 2626	14
81.6°N 26.1°E	0	19 July 1980	0.068	0.0025			-	-			filter 2194	15
81.5°N 26.2°E	0	20 July 1980	0.17	0.0065			-	0.13			filter 976	16
80.6°N 34.0°E	0	21 July 1980	0.26	0.0097			0.056	0.086			filter 2800	17
80.6°N 41.5°E	0	24 July 1980	0.093	0.0034			0.025	0.27			filter 6563	18
80.6°N 41.8°E	0	27 July 1980	0.071	0.0026			0.059				filter 3814	19
80.6°N 42.1°E	0	28 July 1980	0.156	0.0058			0.033	0.105			filter 1346	20
79.2°N 30°E	0		0.23	0.0085			0.032	0.083			filter 1617	21
79.2°N 33.5°E	0		0.133	0.0049			0.038	0.093			filter 2939	22
76.5°N 24.4°E	0		0.086	0.0032			0.058	0.12			filter 4419	23
78.2°N 8.1°E	0	22 Aug 1980	0.29	0.011			-			34.36	water 200	46
79.5°N 4.7°W	0	27 Aug 1980	0.35	0.013			-			31.05	water 200	60
79.6°N 4.7°W	500	27 Aug 1980	0.69	0.026	0.20	7.4	-			34.92	water 90	64 A & C
81.7°N 8.9°W	0	31 Aug 1980	0.25	0.009	0.29	10.9	-	0.42		30.03	water 200	74 A & C
- " -	0	- " -	0.04	0.0015	-	-	0.075	0.19			filter 4900	75
- " -	2000	- " -	0.40	0.015	0.11	4.1	-			34.94	water 95	76 A & C
81.7°N 9.1°W	800	1 Sept 1980	0.16	0.006	0.13	4.8				34.91	water 98	78 A & C
81.7°N 3.8°W	0	2 Sept 1980	0.23	0.0085				0.23		30.7	water 200	79
81.4°N 0.4°E	0	4 Sept 1980	0.35	0.013				0.12		32.2	water 200	83
80.6°N 4.0°E	0	5 Sept 1980	0.34	0.013	0.59	21.8		0.32			water 150	85 A & C
81.4°N 23.3°E	0	11 Sept 1980	0.30	0.011				0.097			water 200	93
81.8°N 24.5°E	0	12 Sept 1980	0.35	0.013				0.21			water 200	96
81.7°N 24.5°E	0	13 Sept 1980	0.39	0.014				0.061		33.3	water 200	108
81.7°N 29.8°E	2700	- " -	0.058	0.002	0.082	3.0				34.95	water 95	110 A & C

80.1°N 30.0°E	250	15 Sept 1980	0.47	0.017	0.57	21.2				34.70	water	92	115 A & C
82.4°N 46.0°E	0	17 Sept 1980	0.37	0.014	0.56	20.8		0.105		33.51	water	200	118 A & C
82.4°N 45.1°E	1100	- " -	0.38	0.014	0.15	5.5		0.28		34.93	water	95	122 A & C
- " -	520	- " -	0.52	0.019	0.40	14.8				34.87	water	98	123 A & C
81°N 36°E	0	16 Sept 1980	0.23	0.0085			0.083	0.085		33.45	filter	682	121
81.9°N 39.2°E	0	18 Sept 1980	0.36	0.013	0.62	23.0				33.45	water	200	125 A & C
79°N 33°E	0	- " -	0.17	0.0065			0.041	0.063		33.15	filter	1675	127
81.4°N 40.3°E	400	- " -	0.45	0.017	0.48	17.8				34.87	water	95	128 A & C
80.8°N 42.4°E	0	17 Sept 1980	0.37	0.014							water	200	117
77.6°N 29.5°E	0	21 Sept 1980	0.33	0.012							water	205	136
75.0°N 27.6°E	0	22 Sept 1980	0.23	0.0085							water	200	140
73.8°N 24.9°E	0	- " -	0.23	0.0085	1.10	40.6					water	200	142 A & C
73°N 25.0°E	0	- " -	0.099	0.0037			0.094	0.24			filter	6193	143
71°N 23°E	0	23 Sept 1980	0.18	0.0066			0.074	0.077			filter	5143	145
71.8°N 23.7°E	0	- " -	0.25	0.0093	2.68	99.2					water	200	146 A & C

Table D.2. Plutonium, Americium and radiocesium in biological samples collected by the Swedish YMER expedition to Spitsbergen - NE Greenland in August-September 1980

Position	Sample	Date	$^{239,240}Pu$ pCi kg^{-1}	$^{239,240}Pu$ Bq kg^{-1}	^{137}Cs pCi kg^{-1}	^{137}Cs Bq kg^{-1}	$^{238}Pu/^{239,240}Pu$	$^{241}Am/^{239,240}Pu$	$^{134}Cs/^{137}Cs$	% dry matter	YMER number
80°25'N 16°03'W Hansens Fjord	Laminaria leaves	Sept 1980	46 (dry)	1.70 (dry)	1270 (dry)	47 (dry)		0.24		~ 20	68
80°25'N 16°03'W Hansens Fjord	Lamiraria stems	Sept 1980	16 (dry)	0.59 (dry)	66 (dry)	2.45 (dry)		0.28		~ 20	69
Isfjord-Svalbard	Fucus sp.	Sept 1980	2.85 (dry)	0.106 (dry)	B.D.L.	B.D.L.		0.11		~ 20	98
Isfjord-Svalbard	Laminaria leaves	Sept 1980	0.63 (dry)	0.023 (dry)	41 (dry)	1.51 (dry)		0.2		~ 20	99
Storøja-Svalbard	Laminaria stems	Sept 1980	3.4 (dry)	0.126 (dry)	< 20 (dry)	< 0.9 (dry)		0.097		~ 20	154
Isfjord-Svalbard	Cladonia alpestris	Sept 1980	53 (dry)	1.96 (dry)	12500 (dry)	464 (dry)		0.40			106
Storøja-Svalbard	Moss	Sept 1980	309 (dry)	11.4 (dry)	17800 (dry)	658 (dry)		0.31			156

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